Chapter 6
Evaluating the Tier III Baseline Ecological Risk Assessment

6.1 Introduction

The Tier III ERA includes longer term field or laboratory studies (1 year or more), and employs more extensive (and more expensive) tests to resolve issues presented by larger sites having complex ecosystems and food webs. Depending on site conditions and complexity, elements of a Tier III ERA may be the most appropriate type of additional investigation following Tier I. The biological sampling conducted in Tier III may involve long-term (chronic) bioassays or tissue analysis of additional organisms or for additional analytes, and/or additional quantitative biological (i.e., population) sampling development. Data from quantitative surveys of populations and comparisons with reference location population characteristics may also be obtained in this tier.[1] Additional chemical analyses of abiotic exposure media also may be appropriate in order to ensure areal and temporal correlation with biological data, Additional ecosystem function or other field data may be collected, including nutrient loss (amount of undecomposed litter), biomarkers, histopathological examinations, or mesocosm studies (in situ biomonitoring). Site-specific input values for key parameters of the model are also needed, if more sophisticated fate and transport modeling is planned at this tier. Biological modeling may include single species modeling to evaluate exposure-response for a species co-located with multiple contaminants, to multiple-species pathway analysis to simulate bioconcentration/bioaccumulation within the community food web.

Results of the additional field and laboratory investigations fill the data gaps identified following completion of the previous tier (Tier II or I) and supplement the results from all studies conducted previously. The combined results are used to present revised risk estimates with less uncertainty than the preceding tiers, and provide a rationale for long-term monitoring (Tier IV) if needed,

[1] These characteristics include abundance, age structure, reproductive potential and fecundity proportion, productivity, standing crop or standing stock (total biomass), food web or trophic diversity, species diversity and dominance, presence of pollution tolerant/absence of pollution intolerant species, etc.

Tier III population studies may be required in the event that there is an apparent decline in a key receptor's population sire that is deemed important in the presence of a low HI, or no apparent effect on population sire in the presence of a high HI. Population studies are typically more long-term and complex, although simple, short-term population studies may be performed in Tier II. Population studies involve taking a census of the number of individuals in each life stage at several points over the course of one to several life cycles or seasons (USAF 1990). These studies can be expanded by including observations of the health or intoxication of individuals at different life stages for each time interval. The temporal aspects of the study design are likely to provide insight into age-related or life-stage-specific sensitivities of the organisms in question.

Tier III may also include sampling for model development or pattern description. Data may be collected to support single-species exposure models that employ Monte Carlo analysis techniques (Appendix E) or integrated fate, accumulation, and effects models, such as the pathways analysis model for estimating water and sediment criteria (Fordham and Reagan 1991). More intensive sampling to describe spatial patterns in biota and the extent of contaminant distribution in relation to these biological patterns may also be conducted in Tier III. Tier III investigations, if needed, are most likely conducted following a Tier II determination of the need for additional biotic data to support modeling efforts. It is possible, however, depending on site conditions, that a Tier III sampling and analysis effort may be the appropriate level of additional investigation following Tier I.

6.2 Problem Formulation

Following completion of the Tier I or Tier II ERA, adequacy of the results to support the FS/RD-RA should be examined again. If it is determined that expanded biological or toxicological investigations are needed to support remediation decisions, then guidance from the USACE (1995b) *Technical Project Planning* document should be followed. Similar to the problem definition stage of Tier II, previously collected Tier I and Tier II data should be reviewed and any data gaps identified.

Once data needs are identified, Tier III problem formulation should commence. The biological sampling methods employed are likely to be more extensive than those used in Tier II, but they should be complementary to those used in Tier II in order to have analogous data. Biological sampling locations should be the same as those in

Tier II unless they did not yield defensible biological data. If additional toxicological testing or tissue sampling is planned, organisms and methods used should complement those used in Tier II. Because of the elapsed time between tiers in the ERA, additional chemical samples may be needed to correlate with the additional biological and toxicological studies conducted in Tier III.

Following are brief descriptions of the field, modeling, and laboratory studies appropriate within Tier III:

6.2.1 Field Studies

- Quantitative biota (population/community) sampling extending over multiple seasons within one year to document seasonal variability of potentially exposed biota.
- Quantitative biota sampling in reference areas employing the same methodology used at the exposure points to provide sufficient data for statistical comparisons with the data collected at exposure points.
- Additional tissue sampling of the key receptor species or their diets or prey.
- Collection of exposure point media (e.g., surface water, sediment) for use in additional acute or chronic (long-term) laboratory bioassays.
- In situ acute or chronic bioassays to determine LC_{50}, LOAEL, or NOAEL contaminant concentrations.
- Additional surveys of Federal- or state-protected species suspected of being exposed to COECs.
- Additional sampling of abiotic exposure point media (e.g., soils, sediment, surface water) to supplement existing chemical data and correlate with the Tier III biological samples.
- Additional collection of abiotic media from reference areas for chemical analyses.

6.2.2 Modeling Studies

- Single-species modeling, which is a toxicity model based on a well-documented exposure-response relationship between a mixture of chemicals and a single species, can be run using Monte Carlo simulations to produce a cumulative distribution of projected ecological risk and can be run using various exposure scenarios representative of different remediation alternatives.
- Multiple-species pathways analysis modeling, which simulates contaminant trophic transfer potential through community food webs.

6.2.3 Laboratory Studies

- Laboratory analysis of biological community samples (e.g., periphyton, benthic invertebrates, plants), as needed for taxonomy.
- Chemical analysis of collected tissue samples for COECs that are known or suspected of bioaccumulating or biomagnifying.
- Acute or chronic bioassays using onsite exposure media in order to determine LC_{50}s LOAELS, or NOAELs.
- Acute or chronic bioassays using doses of COECs suspected of presenting a risk in order to determine LD_{50}s, LQAEL, or NOAEL doses.
- Chemical analysis of exposure point abiotic media for the COECs, specific species of COECs, or selected COECs at detection levels lower than RTVs for the selected ecological receptors.
- Chemical analysis of physical media collected from reference areas.

6.3 Data Collection and Analysis

Data collection from both field and laboratory studios and data analysis should be conducted in accordance with the Tier III work plan and the USACE (1995b) *Technical Project Planning* document. As discussed for Tier II, the work plan should provide, at a minimum, data collection objectives appropriate for Tier III, details of the field studies methods, laboratory analytical methods with quantitation limits described, data quality review methodology, and plans for data presentation and integration with existing data, including data collected in Tiers I and II.

6.4 Revision of the Tier II Era

Following the collection and compilation of biological/ toxicological data from the Tier III field samples and laboratory analyses, the Tier II ERA should be revised to

incorporate the information collected. In contrast to data from Tier II, this additional information is most appropriately used to better quantify the risk assessment. Overall, the additional information provided through Tier III investigations should further reduce the level of uncertainty associated with the ERA.